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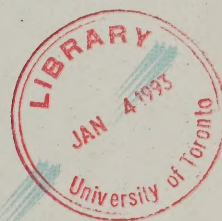
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Royal Commission on National Passenger Transportation

***Air Infrastructure Costing***

Sypher : Mueller International Inc.  
August 1991

RR-04





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Opinions expressed are those of the  
authors and not necessarily those of  
the Royal Commission on National  
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# **AIR INFRASTRUCTURE COSTING**

## **FINAL REPORT**

**Prepared for:**

**Royal Commission on National  
Passenger Transportation**

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**August 1991**



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## EXECUTIVE SUMMARY

Unit costs for airport and air navigation services (ANS) were developed from available financial data related to expenditures associated with airport and aviation infrastructure. Airport sites operated by Transport Canada were compared with those operated by others, and general aviation (ga) ANS costs were compared with U.S. ga costs allocated by the Federal Aviation Administration. The study also examines costs attributed by Transport Canada to the airport and aviation sectors and how these relate to the current level of cost recovery from users.

The 1989/90 program costs for the air mode as presented in Part III of the Transport Canada Estimates totalled \$1.36 billion. This figure is based on cash expenditures and includes branch overhead but excludes internal recoveries. The revenue generated from the air mode in 1989/90 was equal to \$1.02 billion. It is comprised of the Air Transportation Tax (ATT), aircraft fees and charges, and fees from commercial and non-aviation sources. In 1989/90, airline sources were responsible for 82% of the air mode revenue, or \$833 million (including the ATT).

Several infrastructure cost functions were developed. The 98 airports examined were broken down into four size/traffic groups. They are: Toronto/Vancouver; the remaining Major Federal Airports (Calgary, Edmonton, Halifax, Montreal, Ottawa, and Winnipeg); sites with facilities that handle more than 200,000 enplaned plus deplaned passengers a year; and the remaining sites. Several allocation methods were used: movement based-replacement value, weight based-replacement value, movement based-book value, and weight based-book value. Exhibit 1 summarizes the unit costs attributable to commercial air services derived using these methods.

**Exhibit 1. Summary of Commercial Unit Costs**

		Movement Based Allocation		Weight Based Allocation	
		Cost/Pax	Cost/Movement	Cost/Pax	Cost/1000 kg
<b>Replacement Value</b>	Tor./Van.	3.42	104.93	3.42	2.51
	Remain MFAs	5.97	123.19	5.97	3.44
	E/D > 200,000	7.42	56.43	8.39	5.65
	Remaining Sites	43.68	134.20	46.12	14.73
<b>Book Value</b>	Tor./Van.	2.33	67.39	2.33	1.61
	Remain MFAs	3.83	80.15	3.83	2.21
	E/D > 200,000	5.51	50.12	6.48	4.82
	Remaining Sites	22.98	92.57	25.42	9.89

The combination of airport unit costs and ANS costs yields an average total cost function that can be used to determine the average infrastructure cost per passenger to fly to any destination in Canada. The ANS portion of the cost function remains the same for each model, whereas the airport costs are allocated using one of the four methods mentioned above. Using the weight based-replacement value total infrastructure cost function, it is possible to calculate the costs attributable to commercial air services of a trip from Ottawa-Toronto (400 kms). Both the Toronto/Vancouver and the remaining MFA's (Ottawa) cost function would be used. Using a Dash 8 (40 seats) with a gross weight of 15,300 kgs and assuming a load factor of 65%, the cost per passenger is:

$$\begin{aligned}
 \text{Ottawa-Toronto: } & \$3.42(.65 \times 40) + \$2.51(15.3) + \$42.54 + \$5.97(.65 \times 40) \\
 & + \$3.44(15.3) + \$42.54 + \$0.15(400) \\
 & = \$480.25: \$18.47/\text{passenger}
 \end{aligned}$$

Therefore, the total cost of providing Transport Canada infrastructure and services for a trip from Ottawa-Toronto is \$18.47 per passenger.

In Canada it is estimated that general aviation is responsible for 32% of total ANS costs (based on 1988 statistics). This figure is comparable to that of the U.S., where in 1985 general aviation was allocated approximately 26% of ANS costs. Canadian general aviation operators account for a larger portion of ANS costs than their U.S. counterparts because general aviation makes up a greater percentage of the total fleet in Canada.

Transport Canada operated airports are more costly than equivalent non-Transport Canada operated facilities. In part this is due to Transport Canada's Emergency Response Services' policy, whereby staff and equipment on hand depend on the critical aircraft size that use the airport. Non-Transport Canada operated airports are currently not required to meet these standards. Transport Canada airports, especially at the mid-sized airports that receive some scheduled services, also tend to have more staff.



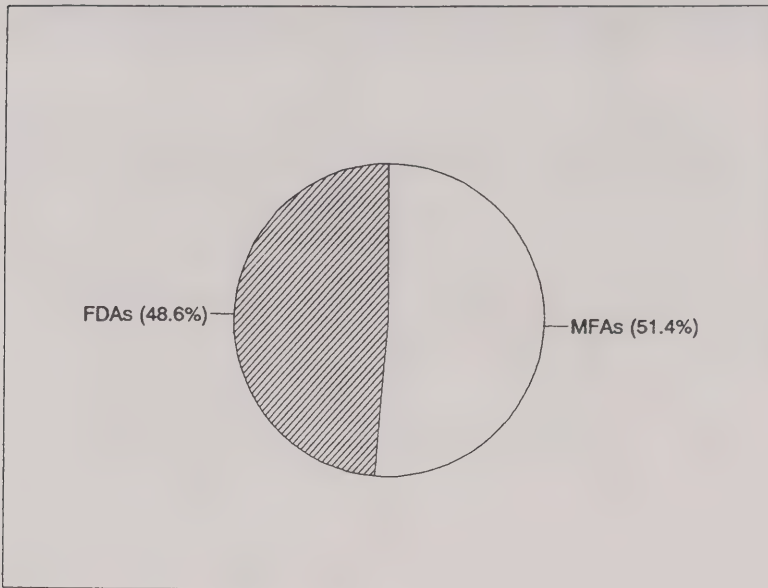
## I AIR INFRASTRUCTURE COSTS AND RECOVERIES

Outlined in Exhibit I-1 are the 1989/90 program cash expenditures for the air mode as presented in Part III of Transport Canada Estimates. Branch overhead is included but internal recoveries are excluded. Exhibits I-2 and I-3 provide a further breakdown by branch and program. Airport program costs are split almost equally between Major Federal Airports (MFA's) and Federally Dependent Airports (FDA's). The MFA group is comprised of the eight largest international airports in Canada. All other sites are classified as FDA's. The large majority of aviation program costs are related to ANS. The major functions within ANS are terminal control services, area control and enroute services and flight service stations. A review of expenditures by line item at MFA's (exhibit I-4) shows that expenditures are comprised of approximately 28% labour, 28% non-labour which includes materials and professional services, 35% capital, and 9% indirect costs which consist of corporate overhead costs and grants in lieu of taxes. FDA expenditures exhibit a very similar structure.

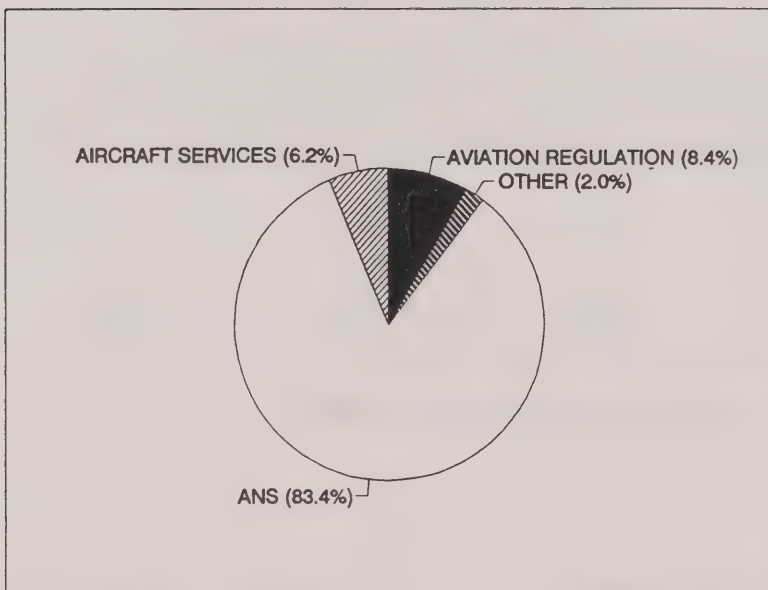
**Exhibit I-1. Air Program Cash Expenditures**

AIR MODE 1989/90 CASH EXPENDITURES			
	Operating (\$M)	Capital (\$M)	Total (\$M)
Aviation	559	230	789
Airports	363	209	572
	\$922	\$439	\$1,361

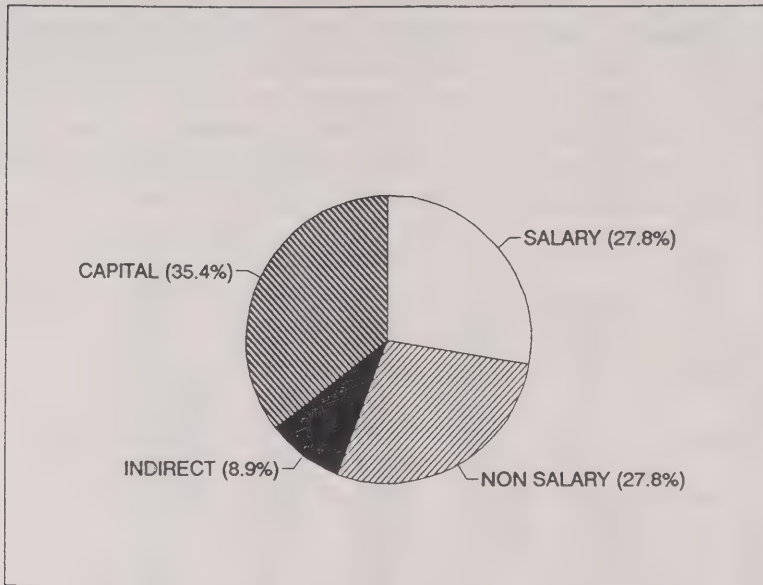
Source: Part III of Transport Canada Estimates



**Exhibit I-2. Airport Program Expenditures 1989/90**



**Exhibit I-3. Aviation Program Expenditures 1989/90**



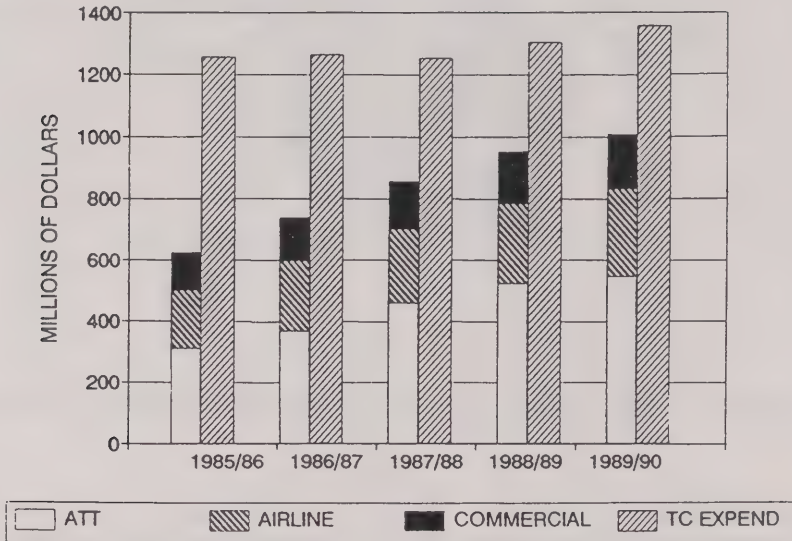
**Exhibit I-4. Major Federal Airport Expenditures Breakdown 1989/90**

Revenue generated from the air mode is comprised of the Air Transportation Tax (ATT), aircraft fees and charges as well as commercial and non-aviation sources. The revenue categories and 1989/90 revenues by branch are shown in Exhibit I-5.

**Exhibit I-5. Air Program Revenue Sources, 1989/90**

REVENUE SOURCES BY BRANCH				
	Aviation(\$M)	Airports(\$M)	Total(\$M)	%
ATT	186	332	518	50.8
Enroute/Other ANS	30	-	30	2.9
Landing Fees	-	128	128	12.6
General Terminal	-	89	89	8.7
Airline Rental	-	50	50	4.9
Other Airline Rev	-	18	18	1.3
Commercial/Indust	-	186	186	18.3
	\$216	\$803	\$1,019	100%

The allocation of ATT between airports and ANS is an arbitrary decision made by Transport Canada from year to year. Exhibit I-6 illustrates the historical level of recovery for the air mode. The level is approximately 75% of Transport Canada aviation cash expenditures, which includes both operating and capital components. This level of recovery is against total expenditures as stated by Transport Canada and does not take into account expenditures that could be considered non-attributable to users.



**Exhibit I-6. Historical Pattern of Cost Recovery**

Of the approximately \$1 billion in revenue generated from the air mode, 82% is generated from airline sources (including the ATT). Exhibit I-7 shows the total airline fees and charges paid by year from 1985/86 to 1989/90. The compound growth rate in airline fees was approximately 10% per annum for the four years.

**Exhibit I-7. Historical Pattern of Airline Fees Including the ATT**

	1985/86	1986/87	1987/88	1988/89	1989/90
Airline Fees (\$M)	\$577	\$627	\$735	\$824	\$833

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Transport Canada has advanced a new cost recovery policy, that if executed as proposed, would see airline fees and charges rise by approximately \$300 million<sup>1</sup> upon full implementation.

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1. Air Transport Association of Canada, 1990 Annual Report.

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## II AIR INFRASTRUCTURE COSTING MODEL

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Transport Canada's Airport branch has readily available data on a site by site basis since cost data and statistics can be easily attributed to each site. The Aviation branch is faced with a much more difficult situation, and can not easily process data on a site by site basis since air navigation services are treated more as a network. Therefore, air navigation costs were assembled at the branch level while airport costs were developed on a site by site basis.

### AIRPORT COSTS

On the airport side, the infrastructure cost models have been broken into categories that best represent the size and traffic differentials that exist between the 98 airport facilities being examined. By grouping sites and running separate models for each, a more accurate picture of the cost function associated with a particular size of airport can be determined. Grouping removes the potential influence of the larger sites on the average cost function that would be produced if airports were treated as a single homogeneous group. The four groups are:

- **Group 1: Pearson and Vancouver** - A cost function was developed for this group as these are the only sites in Canada that are operating at or near capacity. These are the two largest airports in Canada both in terms of facilities and operations and as such would have certain distinct cost functions and asset utilization.
- **Group 2: Remaining Major Federal Airports (MFA) Sites** - The other six MFA sites (Calgary, Edmonton, Halifax, Montreal, Ottawa, and Winnipeg) were grouped together as the facilities are roughly the same size and all play a similar role in the national transportation system.
- **Group 3: Sites Processing or Capable of Handling 200,000 enplaned/deplaned (E/D) Passengers** - In order to be able to handle this passenger volume, a site would require a minimum level of airfield and terminal facilities. In most cases these facilities are adequate to handle volumes of up to 1,000,000 passengers. As the facilities and operations would be similar for sites in this group, it would be logical to expect that the cost behaviour also be similar.

- 
- **Group 4: Remainder of Airports - Below the level of 200,000 passengers,** the sites would be small and would have limited facilities and operations. As such, all these remaining sites have been grouped together.

The airports that are contained in each group are listed in Appendix A.

**Airfield costs** have been allocated at each airport using two methods; movements and weight. Movements represent the total number of airfield arrivals and departures on an annual basis. At congested sites like Pearson and Vancouver a movement based allocation can serve as a reasonable base because time is the scarce commodity, and each movement imposes approximately the same time demands on the facilities and services. However, a movement based allocation is weak at uncongested airports since this method assumes that each movement causes the same amount of "wear and tear" on airport assets, regardless of size. A weight based allocation is a widely accepted practice for fee setting. Weight allocation reflects the fact that some airfield costs increase with aircraft size. Both allocation methods are measured on a dollar per movement basis, eg. an arrival plus a departure.

**Terminal costs** have been measured in relation to the number of passengers (enplaned and deplaned). Terminal costs are allocated solely to commercial aviation with the assumption that general aviation makes limited use of the terminal building.

Costs have been allocated to three user groups; commercial, instrument flight rules (IFR) general aviation (ga), and visual flight rules (VFR) ga. Commercial includes unit toll, charter, and other commercial operations. Unit toll is defined as the transport of people or goods on a toll or price per person or unit. Charter is the transport of a person or good for a price per kilometre or hour to hire the aircraft. Other commercial operations includes flights performed by commercial aircraft other than the unit toll or charter services. IFR ga includes itinerant movements of operators using radio navigation instruments to assist the pilot. VFR ga includes itinerant and all local movements of operators not using radio navigation instruments. In general terms, IFR ga tends to use larger, more sophisticated aircraft, while VFR ga tends to use smaller aircraft.

Separate cost functions were developed for each allocation method using both replacement value of capital and book value of capital in the cost base. Replacement value was used to allow cost comparisons between the various transportation modes. Book value was used to allow a comparison to costs

proposed by Transport Canada in the draft Cost Recovery Policy. Four groups of cost functions were prepared (movement based-replacement value, weight based-replacement value, movement based-book value, and weight based-book value). In each group there is a separate cost function for commercial, IFR ga, and VFR ga. Exhibits II-1 to II-4 summarize the cost functions that were developed.

**Exhibit II-1. Movement Based Airport Infrastructure Cost Using Replacement Value**

	Commercial Cost/ Passenger	Commercial Cost/ Movement	GA IFR Cost/ Movement	GA VFR Cost/ Movement
Toronto/Vancouver	3.42	104.93	91.78	91.78
Remaining MFAs	5.97	123.19	78.98	78.98
E/D > 200,000	7.42	56.43	42.92	42.92
Remaining Sites	43.68	134.20	69.68	69.68

**Exhibit II-2. Weight Based Airport Infrastructure Cost Using Replacement Value**

	Commercial Cost/Passenger	Commercial Cost/1000 kg	GA IFR Cost/1000 kg	GA VFR Cost/1000 kg
Toronto/Vancouver	3.42	2.51	2.35	2.35
Remaining MFAs	5.97	3.44	2.34	2.34
E/D > 200,000	8.39	5.65	5.97	5.97
Remaining Sites	46.12	14.73	14.23	14.23

**Exhibit II-3. Movement Based Airport Infrastructure Cost Using Book Value**

	Commercial Cost/ Passenger	Commercial Cost/ Movement	GA IFR Cost/ Movement	GA VFR Cost/ Movement
Toronto/Vancouver	2.33	67.39	56.95	56.95
Remaining MFAs	3.83	80.15	48.66	48.66
E/D > 200,000	5.51	50.12	36.05	36.05
Remaining Sites	22.98	92.57	47.68	47.68

**Exhibit II-4. Weight Based Airport Infrastructure Cost  
Using Book Value**

	Commercial Cost/Passenger	Commercial Cost/1000 kg	GA IFR Cost/1000 kg	GA VFR Cost/1000 kg
Toronto/Vancouver	2.33	1.61	1.47	1.47
Remaining MFAs	3.83	2.21	1.46	1.46
E/D > 200,000	6.48	4.82	4.82	4.82
Remaining Sites	25.42	9.89	9.00	9.00

Excluded from these airport groupings are the hundreds of community airports located across Canada. Because these airports are small, do not provide scheduled services and have limited financial data readily available, for them, these sites were not included in this study. However, these airports are an essential link to many small communities. The residents, and the businesses that support them, depend heavily on accessibility. This is particularly evident in the north where air is the only means of transportation, enabling the delivery of food and emergency services. These airports are included in Transport Canada's expenditures.

#### **AIR NAVIGATION SERVICES**

Air navigation costs include the cost of air traffic control, flight service stations, and the provision of radio navigation aids. The cost of ANS is divided between local ANS costs and enroute ANS costs. Local ANS costs are the costs of services provided at each airport while enroute costs are the costs of services provided while an aircraft is between airports. The resulting cost functions are:

Commercial = \$42.54/movement + \$0.15 per kilometre

IFR ga = \$41.16/movement + \$0.15 per kilometre

VFR ga = \$82.69/movement + \$1.01 per kilometre

The total infrastructure costs are equal to the airport cost function plus the corresponding ANS cost function. The methodology used to generate these cost equations is detailed in Appendices B and C. The cost data used to derive these cost functions is contained in Appendices D and E.

## TOTAL COSTS

Exhibit II-5 highlights the derivation of a total cost function. The airport costs were allocated using weight based-replacement value, while the ANS part of the cost function remains the same for each model. The combination of these two yields a total cost function that will generate an estimate of the average infrastructure cost per passenger flying to or from any destination in Canada. For example, using the weight based-replacement value total infrastructure cost function, it is possible to calculate the costs attributable to commercial air services of a trip from Ottawa to Toronto (400 kms). Both the Toronto/Vancouver and the remaining MFA's (Ottawa) cost function would be used. Using a Dash 8 (40 seats) with a gross weight of 15,300 kgs and assuming a load factor of 65%, the cost per passenger is calculated as:

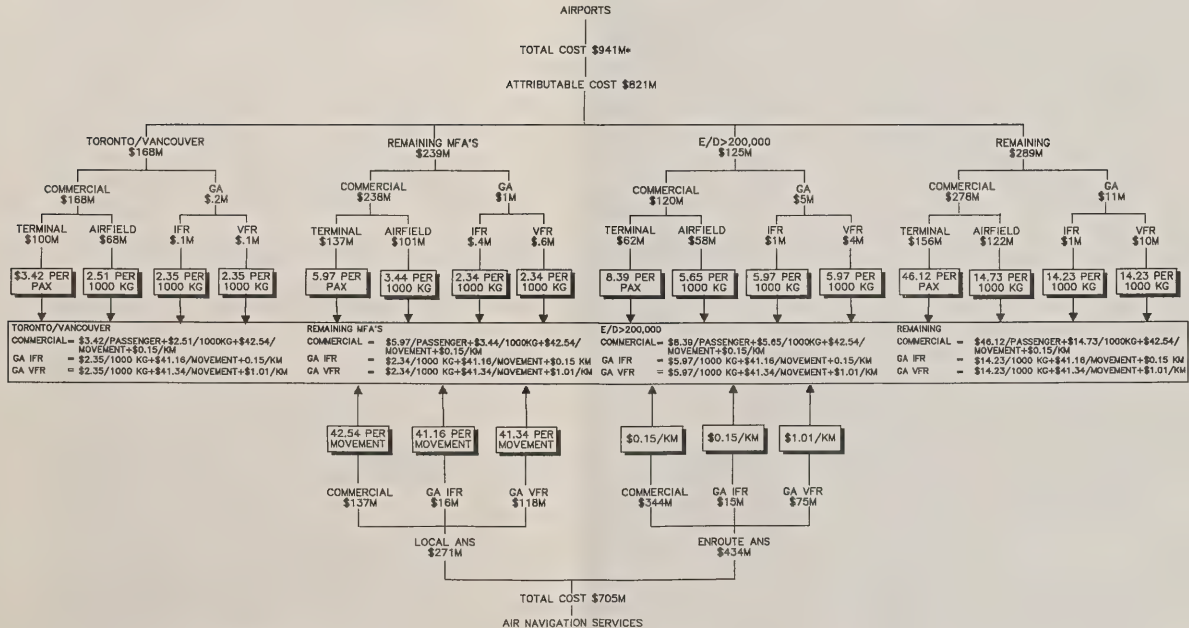
$$\begin{aligned}\text{Ottawa-Toronto: } & \$3.42(.65 \times 40) + \$2.51(15.3) + \$42.54 + \$5.97(.65 \times 40) \\ & + \$3.44(15.3) + \$42.54 + \$0.15(400) \\ & = \$480.25: \$18.47/\text{passenger}\end{aligned}$$

Therefore, the total cost of providing Transport Canada infrastructure and services for a trip from Ottawa to Toronto is \$18.47 per passenger.

Alternatively, using movement based-replacement value the cost per passenger will be:

$$\begin{aligned}\text{Ottawa-Toronto: } & \$3.42(.65 \times 40) + \$104.93 + \$42.54 + \$5.97(.65 \times 40) \\ & + \$123.19 + \$42.54 + \$0.15(400) \\ & = \$617.34: \$23.74/\text{passenger}\end{aligned}$$

**Exhibit II-5. Derivation of Average Total Cost Function  
(Weight Based - Replacement Value)**



\* COSTS FOR FDA SITES ARE INFLATED TO 1980/91 DOLLARS



### III COMPARISON OF CANADIAN AND U.S. GENERAL AVIATION ANS COSTS

In comparing U.S. and Canadian ANS, many differences exist. For example, Canada has seven air traffic control centres (ACC's), while the U.S. has twenty-two air route traffic control centres (ARTCC's), which would facilitate higher facility, equipment, and O&M costs for enroute ANS. Enroute costs tend to be greater for commercial operators since they travel longer distances and are in airspace more often than ga users. It was not feasible to use Canadian data in the U.S. model because the FAA's results are not compatible with the Canadian data. Exhibit III-1 summarizes the FAA's allocation of ANS costs (TRACONs are defined as Towers equipped with Radar Approach Control services).

**Exhibit III-1. Summary of U.S. Cost Allocation  
(Percent)**

	Commercial	GA	State Military
Facility and Equipment	72.0	16.4	11.6
FSS <sup>2</sup> O&M	10.9	76.5	12.7
Navaid Maintenance	52.8	26.9	20.4
Tower O&M	17.3	65.9	16.8
TRACON O&M	62.9	20.9	16.2
ARTCC O&M	53.6	24.0	22.4

In Canada it is estimated that ga is responsible for 35% of total ANS costs (based on 1988 statistics). This figure is comparable to that of the U.S., where estimates in 1985 allocated to ga approximately 32% of ANS costs. It seems reasonable that Canadian ga operators account for a larger portion of ANS cost than their U.S. counterparts because ga makes up a greater percentage of the total fleet in Canada.

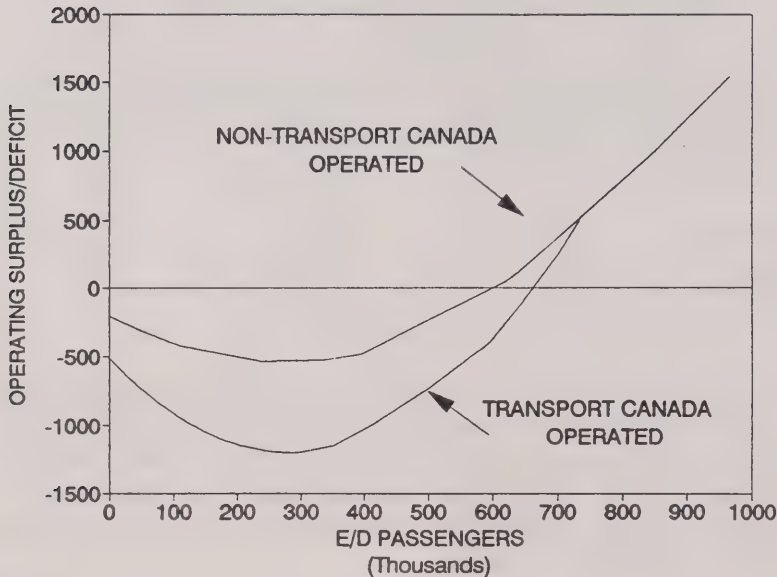
Canada's ga ANS cost may also be higher because there are proportionally more airports in Canada with towers or flight service stations. Of Canada's 6,000 aerodromes, 13% are certified whereas only 5% of the U.S.' 16,000 aerodromes are certified. An aerodrome is defined as any area of land, water or other supporting service that is used and/or equipped in part or in whole for the arrival or departure of aircraft.

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2. Flight Service Station

#### IV COST OF TRANSPORT CANADA VERSUS NON-TRANSPORT CANADA OPERATED AIRPORTS

In examining airport operations between Transport Canada and non-Transport Canada operated facilities, the operating surplus/deficit or subsidy (in thousands of dollars) was regressed against E/D passengers (Exhibit IV-1). Appendix A contains the names of the airports plotted. For airports with E/D passengers less than 200,000, several airports fell outside the norm for operating surpluses or deficits; Goose Bay, Churchill, Resolute Bay, and Gander. These outliers were not included in the analysis since they would widely accentuate the results.



**Exhibit IV-1. Transport Canada vs Non-Transport Canada Airports**

Non-Transport Canada operated airports have much smaller operating deficits than Transport Canada operated airports. This is particularly noticeable up to 300,000 E/D passengers. One of the main contributing factors to this is the cost of Transport's Emergency Response Services (ERS). Under Transport Canada's ERS policy, airports are staffed and equipped based upon the maximum size of aircraft that use the airport. Non-Transport Canada operated airports do not have to abide by this policy (although they often do have ERS services). The result is much higher operating and maintenance costs at Transport Canada operated airports, especially those that receive scheduled services.

Between 300,000 and 400,000 E/D passengers, deficits start to decrease because revenues grow faster than costs as a function of traffic in this size range, although Transport Canada airports still have greater cash operating deficits.

As for the discrepancies between Transport Canada and other airport operators, several explanations for this may exist. For instance, local standards could be more economical than Transport Canada standards. Many Transport Canada airports were developed to serve jet traffic and have not been scaled back to match current operations. For example, in comparing Oshawa airport (non-Transport Canada operated) and Yarmouth (Transport Canada operated), a number of differences are evident.

**Exhibit IV-2. Yarmouth versus Oshawa**

	<b>Yarmouth</b>	<b>Oshawa</b>
Deficit	(700,000)	0
Operating Hours	9	16
Total Movements	10,000	98,000
E/D Passengers	35,000	38,000
Staff (PYs)	20	3

Yarmouth and Oshawa have similar E/D passenger statistics. Oshawa has ten times the movements of Yarmouth and longer hours of operation, but only has 3 people on staff while Yarmouth has 20. Oshawa also uses the local fire department and therefore has no ERS costs. Approximately one-third of Yarmouth's deficit can be attributed to ERS operating and maintenance costs.



**APPENDIX A**  
**LIST OF AIRPORTS**



# TC AIRPORTS BY STUDY GROUPINGS

## GROUP 1

Toronto  
Vancouver

## GROUP 2

Calgary  
Edmonton Intl.  
Halifax  
Montreal  
Ottawa  
Winnipeg

## GROUP 3

Charlottetown  
Fredericton  
Kelowna  
London  
Moncton  
Prince George  
Quebec  
Regina  
Saint John  
Saskatoon  
Sault Ste. Marie  
St. John's  
Sudbury  
Sydney  
Thunder Bay  
Timmins  
Victoria  
Whitehorse  
Windsor  
Yellowknife

## GROUP 4

Abbotsford  
Bagotville  
Baie Comeau  
Baker Lake  
Cambridge  
Campbell River  
Castlegar  
Charlo  
Churchill  
Coral Harbour  
Cranbrook  
Deer Lake  
Earlton  
Eastmain  
Eureka  
Fort McMurray  
Fort Nelson  
Fort Resolution  
Fort Simpson  
Fort Smith  
Fort St. John  
Gander  
Goose Bay  
Gore Bay  
Grande Prairie  
Hamilton  
Hay River  
Iles de Mad  
Inuvik  
Iqaluit  
Kamloops  
Kapuskasing  
Kenora  
Kuujuaq  
Lethbridge  
Mont Joli  
Muskoka  
Nanisivik  
Norman Wells  
North Battleford  
North Bay  
Penticton  
Port Hardy  
Prince Rupert  
Quensel  
Red Lake  
Resolute Bay  
Rouyn/Noranda  
Sandspit  
Sarnia  
Schefferville  
Sept Iles  
Smithers  
St. Anthony  
St. Leonard  
Stephenville  
Swift Current  
Terrace  
The Pas  
Thompson  
Tofino  
Tuktoyuktuk  
Val d'Or  
Wabush  
Watson Lake  
Wemindji  
Wiarton  
Williams Lake  
Yarmouth  
Yorkton

# AIRPORTS BY TRANSPORT CANADA CATEGORY

MFA	ex-MFA	FDA	FDA
Toronto	Charlottetown	Abbotsford	Norman Wells
Montreal	Fredericton	Bagotville	North Battleford
Vancouver	Gander	Baie Comeau	North Bay
Calgary	London	Baker Lake	Penticton
Winnipeg	Moncton	Cambridge	Port Hardy
Edmonton Intl.	Quebec	Campbell River	Prince George
Halifax	Regina	Castlegar	Prince Rupert
Ottawa	Saint John	Charlo	Quensel
	Saskatoon	Churchill	Red Lake
	St. John's	Coral Harbour	Resolute Bay
	Sydney	Cranbrook	Rouyn/Noranda
	Thunder Bay	Deer Lake	Sandspit
	Victoria	Earlton	Sarnia
	Windsor	Eastmain	Sault Ste. Marie
		Eureka	Schefferville
		Fort McMurray	Sept Iles
		Fort Nelson	Smithers
		Fort Resolution	St. Anthony
		Fort Simpson	St. Leonard
		Fort Smith	Stephenville
		Fort St. John	Sudbury
		Goose Bay	Swift Current
		Gore Bay	Terrace
		Grande Prairie	The Pas
		Hamilton	Thompson
		Hay River	Timmins
		Iles de Mad	Tofino
		Inuvik	Tuktoyuktuk
		Iqaluit	Val d'Or
		Kamloops	Wabush
		Kapuskasing	Watson Lake
		Kelowna	Wemindji
		Kenora	Whitehorse
		Kuujuuaq	Wiarton
		Lethbridge	Williams Lake
		Mont Joli	Yarmouth
		Muskoka	Yellowknife
		Nanisivik	Yorkton

# AIRPORT COSTS ANALYSED IN SECTION IV

TRANSPORT CANADA OPERATED		NON-TRANSPORT CANADA OPERATED
Abbotsford	Penticton	Edmonton Muni
Baie Comeau	Port Hardy	Kelowna
Baker Lake	Prince George	Toronto Island
Cambridge	Prince Rupert	Sudbury
Charlottetown	Quebec	Thompson
Coral Harbour	Quensel	Bagotville
Deer Lake	Regina	Hamilton
Earlton	Saint John	Castlegar
Eureka	Sandspit	Campbell River
Fort McMurray	Saskatoon	Cranbrook
Fort Nelson	Sault Ste. Marie	Sarnia
Fort Simpson	Sept Iles	Kingston
Fort Smith	Smithers	Oshawa
Fort St. John	St. Anthony	Red Lake
Fredericton	St. John's	Kenora
Gore Bay	Stephenville	Charlo
Grande Prairie	Sydney	Schefferville
Hay River	Terrace	Wemindji
Iles de Mad	The Pas	Eastmain
Inuvik	Thunder Bay	Swift Current
Iqaluit	Timmins	Yorkton
Kamloops	Tofino	St. Leonard
Kapuskasing	Tuktoyuktuk	North Battleford
Kuuujuaq	Val d'Or	Fort Resolution
Lethbridge	Victoria	
London	Wabush	
Moncton	Watson Lake	
Mont Joli	Whitehorse	
Muskoka	Wiarton	
Nanisivik	Williams Lake	
Norman Wells	Windsor	
North Bay	Yarmouth	
	Yellowknife	



## **A. APPROACH**

A multi-step approach was used to address the three objectives of this project. The process was interactive as a number of steps were undertaken concurrently and the findings and conclusions from one task had the potential to impact the output or methodology developed in another. The overall approach in the conduct of this study was to:

- determine the type(s) of financial data that would be considered relevant for inclusion in the cost base;
- determine the potential sources and availability of the required data;
- undertake the data gathering exercise and develop a data base of airport and aviation infrastructure costs;
- develop cost allocation methodologies; and
- prepare cost models.

Each of these steps is elaborated below.

## **B. DETERMINATION OF COST COMPONENTS REQUIRED FOR COSTING OF AIR MODE SERVICES AND FACILITIES**

This task addressed a number of issues. The first issue was to determine the level of detail that would be required to allow meaningful comparisons to other transportation modes. Data could be assembled at either a branch level (i.e. - Airports Group and Aviation Group) or on a site by site basis. As the Commission will most likely review costs between modes at the average cost level, the project team undertook a method of gathering data that would enable this. Thus, air navigation costs were assembled at the branch level while airport costs were developed on a site by site basis.

The next task was to determine the cost components that should be included in the cost base. The three major cost components to be considered for inclusion were operating and maintenance costs, capital costs and corporate

overhead costs. Although there was no issue with the concept of including each of these elements, there was an issue associated with how the capital costs should be calculated and what level of corporate overhead costs should be included.

In order to allow cost comparisons between the various transportation modes it was deemed that the capital infrastructure would have to be included in the cost base on a current value basis which was most appropriately represented by replacement value. The methodology used to calculate the replacement value is discussed in a latter section of this Appendix. Book value of capital assets is also used to allow for a comparison of costs as calculated here with those published by Transport Canada.

It was determined that there is no causality between the Transport Canada allocation of corporate overhead to operating sites and the level of service provided, with current allocations of up to 50% of direct site operating costs. In this study, no overhead costs were allocated to MFA sites as they may be considered self-sufficient. These sites have a full compliment of management and administrative functions and do not rely on Headquarters for processing services on activities. Therefore, all overhead costs are allocated between the ex-MFA's and the FDA's.

## **C. REVIEW OF DATA SOURCES**

After determining the types of data and level of detail required, the project team undertook the task of investigating the availability of this information. The search for data was centered around five main sources of information. Each is described below:

1. **Statistics Canada Publications** - Statistics Canada catalogue 51-206 entitled "Canadian Civil Aviation" was used to obtain information on commercial carriers' operating activity. This is a public document that is readily available from the Department or the public library, and included such information as enplaned/deplaned domestic passengers, domestic passenger-kilometers flown, and domestic hours flown.
2. **Transport Canada Publications** - Transport Canada publishes a number of documents that are publicly available which contain a variety of traffic and passenger statistics and forecasts for individual Canadian airport sites. The types of information contained in these documents include:

- economic indicators;
- aviation forecast assumptions;
- passenger traffic statistics and forecasts (E/D);
- cargo tonnage statistics and forecasts; and
- itinerant aircraft statistics and forecasts.

3. **Transport Canada Financial Statements** - The Department prepares financial statements for individual sites. The level of detail, timeliness, public access and degree of accuracy depends on the airport grouping. A listing of the Transport Canada sites and current groupings is contained in Appendix A.

For the eight largest sites (Dorval and Mirabel are considered as one) or Major Federal Airports (MFA's) which are part of the Airport Revolving Fund (ARF), financial statements are produced on an annual basis which conform to generally accepted accounting principles. The statements are contained in a publicly available document entitled "TP 1300 Self-Supporting Airports and Associated Ground Services Revolving Fund, Financial Statements for the year ended 199X".

For the next fourteen largest sites, which were once part of the ARF and are now known as Federally Dependant Airports (FDA's), annual financial statements are produced by the site financial officers and submitted to the Financial Advisor of the Airports Group at Headquarters. Although these statements are not published or audited like the MFA sites, copies can be obtained through Headquarters personnel and represent a reasonably accurate source of site costs and infrastructure.

For the remaining sites, which are also classified as FDA's, financial statements are not prepared on an annual basis and are only available on a timely basis when Transport Canada undertakes special studies to update the Department's historical financial database. A complete update of this database was last undertaken for the fiscal year 1987/88.

4. **Transport Canada Internal Management Studies** - The Department and specifically the Airports and Aviation branches undertake special management studies to satisfy internal information needs. A number of financial and costing studies have been completed recently which provide additional detailed data on the costing relationships which exist at airport sites. An example of this type of data would be the detailed cost

allocation studies which were completed for MFA sites for the year 1988/89. There are a number of other studies which contain financial analysis and data which could be used to support the costing of the air mode infrastructure. The main issues with this source are trying to determine what projects have been undertaken or completed, identifying the source of the study and locating it .

5. **Transport Canada Estimates** - The Department must submit estimates outlining operating and capital expenditures for the coming fiscal year. Part III of the Estimates provides an excellent reference document highlighting cash operating and capital expenditures at the branch level. Some additional detail is provided although site by site expenditures are not provided. This document provides a solid cross check against other financial data that is produced by the Department as it contains both historical and forecast spending patterns.
6. **Information Provided to Associations/External Parties** - Over the past few years, a number of parties external to Transport Canada have made requests for financial data to aid them in the analysis of such things as proposed changes to the fee regulations. This data is in the public domain and is a valuable source of information.

Exhibit B-1 maps the data requirements against the most appropriate and readily available source.

#### Exhibit B-1. Data Matrix

<u>DATA</u>	<u>SOURCE</u>
Total E/D Passengers	Statistics Canada
Domestic E/D Passengers	Canadian Civil Aviation 1988, Statistics Canada
Domestic Commercial Passenger-Kms	Canadian Civil Aviation 1988, Statistics Canada
Total Commercial Aircraft Movements	Aircraft Movement Statistics, Transport Canada
Domestic Commercial Aircraft Movements	Aircraft Movement Statistics, Transport Canada
Total ga Movements	Aircraft Movements Statistics, Transport Canada

**Exhibit B-1. Data Matrix (Continued)**

<b><u>DATA</u></b>	<b><u>SOURCE</u></b>
Domestic ga Movements	Aircraft Movement Statistics Transport Canada
Domestic ga IFR Movements	Statistics Canada
Total ga Hours Flown	SYIPHER:MUELLER International Inc.
MFA Financial Data	TP1300, Transport Canada
Ex-MFA Financial Data	Transport Canada
FDA Financial Data	Transport Canada
ANS Costing Data	Transport Canada
U.S. Cost Allocation Methodology	Allocation of Federal Airport and Airway Costs for FY1985, U.S. Department of Transportation, Volumes 1-6

Separate data bases were developed for airports and ANS costing. The composition of each is described below.

**D. AIRPORTS**

The data base for airports contains site-specific data for 98 sites. Information related to expenditures and the allocation basis was gathered at this level as it was readily available and involved minimal incremental work to record. The data is also summed to give an overall cost for the airports infrastructure.

The methodology used to gather the expenditures is highlighted below.

**Operating and Maintenance Costs**

Direct operating cost excluding depreciation was gathered for each site. The methodology and source varied by airport grouping (MFA, ex-MFA and FDA). For MFA's, total direct operating costs and operating costs by profit centre were available which allowed easy removal of costs that were not to be recovered from users. Costs associated with concession/groundside facilities and industrial areas were available from detailed costing studies that were performed in 1988/89, which allocated a portion of site costs to each of these profit centres.

For the fourteen ex-MFA's total direct operating costs and costs associated with concession/groundside facilities and industrial areas were available for 1987/88 from Transport Canada's Financial Projection System which also allocated a portion of site costs to each of these areas or profit centres.

The direct total operating costs and industrial costs for the remaining FDA's was extracted from Transport Canada's Statement of Revenue and Expenses. As the financial data recorded for the FDA sites is minimal and somewhat suspect, a proxy of 10% was used to remove costs associated with concession/groundside facilities. It was further assumed that the industrial profit centre is operated on a break-even basis and as such, expenses should equal revenue generated. Data was available on industrial rentals which then served as a proxy for the costs associated with this area.

Overhead costs were available in the Transport Canada's Proposed New Cost Recovery Policy: Phase II Discussion Paper (TP10041). Included was Airport Group overhead and an allocation of Transport Canada corporate overhead. No overhead costs were allocated to the MFA's since they are considered to be self-sufficient and have a more formalized management structure than the ex-MFA's and FDA's.

### **Capital Costs**

Capital costs were, for the primary analysis, to be presented at current value which was best represented by replacement cost. As the Department only recorded historical cost and accumulated depreciation for fixed assets, no readily accessible source of data was available to estimate the appropriate annual replacement costs to be included. The project team developed a methodology to estimate replacement value based on historical values and calculate an annual cost relating to this value.

Site specific historical book value and accumulated depreciation data formed the backbone of the methodology and calculation. The accumulated depreciation was divided by the average annual depreciation expense to proxy the average age of the asset base, from which the original year of expenditure for the base was calculated. This original year was then used to determine the factor that would be applied to the original book value to restate it in terms of 1990/91 dollars. The factors were based on the Statistic Canada's Implicit Price Index for Total Construction. If the asset base increased by more than 20% in any one year, the amount of the expenditure was removed from the cost base and inflated by the factor that corresponded to the year of the expenditure.

As a cross check, the replacement cost based on facility size (for terminal and runway assets) and current construction costs were calculated for a number of sites. The replacement value was determined for a range of sites to ensure the depreciation based methodology was reasonable.

The replacement value was then divided by a factor of 30 to determine the annual depreciation of capital assets. This value of 30 represents the average life of assets on an airport site, with a terminal building having an average life of 40 years and the runways and associated facilities having an average life of 20 years. The cost of capital component was calculated by multiplying capital replacement value by an interest rate of 10% and then by a factor of 50%. This was done to approximate the average value of the asset over its useful life.

This methodology was applied to every site in the data base. Appendix D includes a step by step description of how each column was derived in the spreadsheet.

## **E. AIR NAVIGATION SERVICES**

The data base was developed at the program level (local and enroute) as data was not readily available for specific sites or installations. The methodology used to approximate operating and capital costs for ANS services and facilities is outlined below. Separate data bases were developed for each program.

### **Operating and Maintenance Costs**

Operating costs for both local and enroute facilities were derived from data provided by Transport Canada. The data was available in a form which separated local from enroute services and isolated domestic and international enroute services. The international services (Polar and Oceanic) are near full cost recovery. Thus, both revenues and expenses were excluded from the calculations, leaving a reasonably accurate picture of the costs and revenues of domestic enroute services. This data was also available from Part III of the estimates, although the detail to allocate costs to international enroute services for area control centres and flight service stations was not available. As with the airport costing exercise, costs represent only direct operating costs and exclude depreciation.

Overhead costs are extracted from Transport Canada's Proposed New Cost Recovery Policy: Phase II Discussion Paper (TP10041). For ease of allocation, overhead is comprised of ANS Regulation costs, ANS Safety costs, ANS Branch overhead, and Allocation of Transport Canada Corporate overhead.

### **Capital Costs**

Similar to airport capital assets, it was determined that the most appropriate value to include in the cost base was replacement cost. The replacement value was determined by reviewing the current asset base and known major expenditures (such as RAMP and MLS), and estimating what it would cost to replace this program. This task was undertaken by a member of the project team with extensive experience in the estimation of ANS facility requirements and costing.

The replacement cost for local and enroute facilities was divided by a factor of 20 which represents the average life of ANS capital assets. A cost of capital component was calculated using an interest rate of 10%.

## **APPENDIX C**

### **DEVELOPING INFRASTRUCTURE COST MODELS**



## **A. DEVELOPMENT OF DATABASE**

The first task undertaken was the development of cost databases for airport and ANS infrastructure. The consultants determined which cost components and accompanying level of detail were required to produce meaningful cost models. After determining the required data, the task of investigating the availability of this information was assessed, keeping in mind the principle of public availability and accessibility. The cost categories and sources are highlighted in Appendix B.

After identifying the most appropriate source of data, the project team undertook the tasks of gathering the data and compiling the database. Where the required data was not available or lacking in substance, a methodology was developed to generate the information.

A number of judgements were developed which helped to ensure consistency in the gathering of data. The assumptions are outlined below:

- historical data is expressed in terms of 1990/91 dollars. It has been assumed that the operational and financial relationships that existed when the data was gathered are still valid today, and the level of costs is affected by inflation only;
- local ANS services are provided for the benefit of all aviation users, including transborder and international movements, and IFR and VFR general aviation (ga) movements;
- enroute ANS services are provided only for the benefit of domestic movements and therefore international enroute services are not considered within the scope of this study. These costs are budgeted as separate items by Transport Canada;
- site operating costs represent only direct costs and exclude depreciation;
- for MFA and ex-MFA sites, expenses associated with concession space, which are not recovered from commercial users, were derived from profit centre statements. For all other sites, a proxy of 10% of operating costs was used. This approximates the average amount of terminal floor space that should be dedicated to concessions;

- for MFA sites, expenses associated with the industrial area, which are not recovered from commercial or ga users, were derived from profit centre statements. For all other sites, it was assumed that the industrial profit centre operates on a break-even basis and industrial costs equal industrial revenues;
- cargo is handled on the industrial side and generally not through the terminal, therefore all the airport costs associated with cargo activity were allocated to the airfield;
- costs associated with state and military aircraft were removed from site operating expenses. Estimates were obtained from Transport Canada;
- emergency response service (ERS) costs are attributed strictly to the commercial users of the airfield;
- profit centre data was available for MFA sites. For ex-MFA sites, data was available to allocate a portion to the airside, with the remainder of the attributable costs being allocated to the terminal. For FDA sites, airfield costs were estimated by regressing the ex-MFA airfield costs against attributable costs. The remainder was allocated to the terminal profit centre;
- no overhead costs were allocated to MFA's. Total corporate overhead costs are allocated among the remaining sites;
- the analysis was undertaken purely from a cost perspective. The term "cost" is used to reflect the expenses Transport Canada incurs, not the price they charge users;
- cost of capital was calculated using an interest rate of 10% and a factor of 50% to approximate the average value of the asset over its useful life;
- reliever airports which serve only ga traffic were not included in the study; and
- from a modelling perspective, the costs of Regulatory and Safety Programs were treated as ANS overhead costs.

The following assumptions pertain solely to weight based analysis:

- the commercial aircraft weight at each airport only includes aircraft weighting more than 4000 kg; and
- IFR and VFR ga aircraft weight was derived using an average weight of 1100 kgs.

## **B. COST ALLOCATION METHODOLOGY FOR INFRASTRUCTURE COSTS**

The activities associated with the development of each step of the cost models are described below.

### **Defining User Groups**

The two primary user groups of airport and ANS facilities are commercial and ga. Commercial is defined to include unit toll, charter, and other commercial operators. Unit toll is defined as the transport of people or goods on a toll or price per person or unit. Charter is the transport of a person on good for a price per kilometre or hour, to hire the aircraft. Other commercial operations include flights performed by commercial aircraft other than unit toll or charter services. The ga user group can be further split into two distinct subgroups; IFR and VFR.

### **Determining Attributable Costs**

Not all costs included in site operating expenses are driven by commercial or ga users as sites today are involved in a myriad of non-aviation activities. As such, it is not reasonable to attribute the costs of these activities to aviation users. To 'cleanse' the database the following items were removed: concession expense, industrial area expense, and State and Military expense.

### **Determining Facility Usage**

It is an accepted practice to view an airport as being comprised of a number of profit centres. In Canada, there are three such profit centres: airfield, terminal, and industrial, each having a different usage pattern. The main difference in the utilization of facilities relates to the terminal building. Ga users normally use the facilities of a fixed based operator for the enplanement or deplanement of passengers and very rarely access

the main terminal building. Because of this, all terminal profit centre costs are allocated to commercial users. Airfield costs are allocated to all users while industrial costs are excluded from the exercise as facilities in this area are not considered infrastructure assets.

In addition to different facility usage, there are certain services that are provided to or driven by one user group. The prime example of this is Emergency Response Services (ERS). The costs associated with this service can be solely attributed to commercial users. Costs associated with ERS were backed out before airfield costs were allocated between commercial and ga users, and later added back to commercial costs.

Although ANS is considered a single profit centre, a similar exercise was undertaken to split the costs between the user groups as different facilities and services were linked to specific users. Local flight service station (FSS) operating and capital costs were attributed to all users groups, while the remainder of local ANS costs were deemed to be driven by the needs of only commercial and IFR ga users.

A review of enroute ANS facilities and services also showed a similar pattern with specific requirements linked to certain user groups. VFR ga users drive the costs associated with enroute FSS, non-directional beacons and very high frequency omni directional radio range (VOR) assets. The remaining enroute ANS costs are allocated between commercial and IFR ga users.

#### **Analyzing Potential Allocation Bases**

After ascertaining which costs should be allocated to specific user groups, the appropriate output/activity for allocating the remaining joint costs between users was investigated. There are a number of outputs or measures of activity that are readily available. Joint costs were not allocated using theoretical economic models such as marginal cost. Each of the outputs are described below along with the applicability to airport and ANS expenditures.

- **Movements** - This represents the total number of airfield arrivals and departures on an annual basis. The split between commercial and ga is based on the earlier definition. Movement based allocations are weak for airfield costs at uncongested airports as this base assumes that each movement, regardless of size causes the same "wear and tear" on airport assets. At congested sites, it could

serve as a reasonable base as capacity is the limiting factor. For allocating ANS costs, movements is a defensible base as the services provided do not grow proportionately with aircraft size, and air traffic controllers regard "a plane as a plane as a plane". This activity measure is weak for allocating terminal assets as it ignores seating capacity and load factor both of which drive the demand for terminal assets.

- **Weight** - The use of weight for allocating joint airfield costs is a universally accepted practice. All 158 states reporting to ICAO in 1989 levied landing fees at international airports based on some weight formula. Many countries have graded scales where rates increase on a per tonne basis as the weight category gets larger. Weight is used in this manner as it incorporates the fact that airfield costs increase with aircraft size (at least to a certain level). The principal factors which vary according to aircraft size and weight are:
  - width and strength of taxiways
  - width, length and strength of runways
  - number and configuration of high speed turn-offs.
  - maintenance costs (i.e. snow clearing)

There are some issues associated with use of weight as an allocation base. If a single fee per tonne is used, it assumes that each user group requires the same set and type of airside facilities and each requires the same level of service. This may result in some inequities between user groups. This base is weak for ANS as costs associated with these facilities are driven primarily by usage and distance flown and not size.

- **Passengers** - The potential usage of this activity measure would be in relation to the determination of terminal cost functions. Terminal costs are not allocated between user groups for the reasons discussed previously.

Because each of the bases had certain shortcomings, a series of models would be run using both weight and movements for allocating costs between users.

### **Determining Units for Cost Models**

As the models were formatted to state costs on a per unit basis, the next step undertaken was to determine what the appropriate unit(s) would be. The same units that were analyzed in the last task were investigated for model suitability. Outlined below is base for each major cost category:

- **Airfield** - As separate model runs were undertaken using weight and movements to allocate costs between user groups, cost per unit was developed to be consistent with the allocation base. Thus the movement based run stated costs in terms of cost per movement and the weight based run stated costs in terms of cost per 1000 kg.
- **Terminal** - As costs for this facility are driven by passengers, costs were stated on a per passenger basis. This base was applicable to both model runs.
- **ANS** - ANS costs were split into two major components - local and enroute. Weight was not considered for allocating ANS costs as these services are based on time and distance travelled. Local costs were allocated based on each users' tower movements and FSS movements and costs were stated on a per movement basis. Enroute costs were allocated on the basis of total domestic kilometres flown by each group and were stated as a function of the number of kilometres flown.

### **Grouping of Airports**

Canadian airports can logically be grouped together in a number of categories based on size and type of operation. By grouping sites and running separate models for each, a more accurate picture of the average cost composition associated with a particular size of airport can be determined. Grouping removes the potential influence of the larger sites on the average cost function that would be produced if airports were treated as single homogeneous group. The four groups are described below:

- **Pearson and Vancouver** - A cost function was developed for this group as these are the only sites in Canada that are operating at or near capacity. These are the two largest airports in Canada both in terms of facilities and operations and have distinct cost functions and asset utilization.

## C - 7

- **Remaining MFA Sites** - The other six MFA sites were grouped together as the facilities are roughly the same size and all play a similar role in the national transportation system.
- **Sites Processing a Minimum of 200,000 E/D Passengers** - In order to be able to handle this passenger volume, a site would require a minimum level of airfield and terminal facilities. In most cases these facilities are adequate to handle volumes of up to 1,000,000 passengers. As the facilities and operations would be normally similar for sites in this group, it would be logical to expect that the cost behaviour also be similar.
- **Remainder of Airports** - Below the level of 200,000 passengers, the sites would be small and would have limited facilities and operations. As such, all remaining sites have been grouped together. There is logical break point for further refinement of the remaining sites.

The airports that are contained in each group are listed in Appendix A.



**APPENDIX D**  
**INFRASTRUCTURE COST MODEL DATA (MOVEMENT BASED)**  
**AND ANS COST MODEL**

**Note:** Because of the history of land acquisition and the method used to calculate commercial airfield capital costs, caution should be given when looking at airports on a site by site basis.







## DESCRIPTION OF THE MOVEMENT ALLOCATION SPREADSHEET.

COLUMN A: NUMBER OF SITES.

COLUMN B: OPERATOR OF AIRPORT, TC=TRANSPORT CANADA, N=OTHER.

COLUMN C: PROVINCE AIRPORT IS LOCATED IN.

COLUMN D: AIRPORT NAME.

COLUMN E: SCHEDULED ITINERANT MOVEMENTS (ALL MOVEMENTS EXTRACTED FROM 1988 AIRCRAFT MOVEMENT STATISTICS).

COLUMN F: CHARTER ITINERANT MOVEMENTS.

COLUMN G: OTHER COMMERCIAL ITINERANT MOVEMENTS.

COLUMN H:(HIDDEN) PRIVATE ITINERANT MOVEMENTS.

COLUMN I: ITINERANT GA IFR MOVEMENTS =  $H \times .52$  FOR AIRPORTS WITH TOWERS WHERE .52 IS THE % OF IFR MOVEMENTS, AND  $H \times .28$  AT TOWERED AIRPORTS WITH FSS WHERE .28 IS THE % OF IFR MOVEMENTS AT FSS AIRPORTS.

COLUMN J:(HIDDEN) PRIVATE LOCAL MOVEMENTS (ATTRIBUTED TO VFR).

COLUMN K: LOCAL AND ITINERANT VFR MOVEMENTS =  $J + (H - I)$ , WHERE  $H - I$  IS THE NUMBER OF VFR MOVEMENTS AT AIRPORTS WITH TOWERS AND FSS.

COLUMN L:(HIDDEN) MILITARY MOVEMENTS.

COLUMN M:(HIDDEN) CIVIL MOVEMENTS.

COLUMN N: TOTAL MOVEMENTS (EXCLUDING MILITARY AND CIVIL)=  $E + F + G + H + J$ .

COLUMN O: PERCENT OF COMMERCIAL MOVEMENTS =  $(E + F + G) / N$

COLUMN P: PERCENT OF PRIVATE MOVEMENTS THAT ARE VFR  $[K / (I + K)]$ , WHERE  $K$ =VFR MOVEMENTS AND  $I + K$  IS TOTAL MOVEMENTS.

COLUMN Q:(HIDDEN) 1987 ENPLANED/DEPLANED PASSENGERS.

COLUMN R: 1988 ENPLANED/DEPLANED PASSENGERS.

COLUMN S: TOTAL OPERATING EXPENSES EXCLUDING DEPRECIATION (AN INPUTTED NUMBER, MFA AND EXMFA COSTS ARE CALCULATED FROM NET INCOME STATEMENT IN ATAC APPENDIX AND IS EQUAL TO SALARIES+ BENEFITS+ OTHER DIRECT AND WERE ALREADY IN 90/91 DOLLARS, AND FDA COSTS ARE CALCULATED FROM TC STATEMENT OF REVENUE AND EXPENSE AND IS EQUAL TO TOTAL OPERATING EXPENSES LESS DEPRECIATION AND ARE IN 1987/88 DOLLARS).

COLUMN T: CONCESSION EXPENSE (INPUTTED NUMBER WHERE MFA AND EXMFA COSTS ARE CALCULATED FROM ATAC APPENDIX STATEMENT OF GTF CALCULATION AND EQUALS CONCESSION COST+GROUND COSTS AND ARE IN 90/91 DOLLARS, FDA COST IS 10% OF TOTAL OPERATING EXPENSES AND IS THEREFORE IN 1987/88 DOLLARS).

COLUMN U: INDUSTRIAL EXPENSE (INPUTTED NUMBER, WHERE MFA AND EXMFA COSTS ARE CALCULATED FROM STATEMENT OF INDUSTRIAL NET INCOME IN ATAC APPENDIX AND IS EQUAL TO SALARIES+ BENEFITS + OTHER DIRECT COSTS WHICH WERE ALREADY IN 90/91 DOLLARS, FDA COSTS ARE FROM STATEMENT OF REVENUE AND EXPENSES AND EQUAL INDUSTRIAL RENTALS AND ARE IN 1987/88 DOLLARS).

COLUMN V: STATE AND MILITARY COSTS (INPUTTED NUMBER FROM TC DATA ON ALLOCATION OF COSTS TO STATE AND MILITARY ON A SITE BY SITE BASIS IN 1987/88 DOLLARS).

COLUMN W:(HIDDEN) NON-ATTRIBUTABLE COST, A CATCH ALL COLUMN TO DEDUCT ANY OTHER NON-ATTRIBUTABLE COSTS BY MULTIPLYING (S-T-U-V) BY A CERTAIN PERCENTAGE REPRESENTATIVE OF THAT NOT ATTRIBUTABLE TO MFA/EXMFAs AND ANOTHER PERCENTAGE REPRESENTATIVE OF FDAs.

COLUMN X: EMERGENCY RESPONSE O&M COSTS (INPUTTED FROM SYPHERS REPORT ON CFR VOLUME II, APPENDIX ON CFR ANNUAL COSTS, AND EQUALS PAY+ BENEFITS+ SUPPLIES+ REGIONAL OVERHEAD + HQ OVERHEAD-CFR REVENUES, AND IS IN 1986/87 DOLLARS).

COLUMN Y: ATTRIBUTABLE O&M COST RECOVERABLE FROM USERS = S-T-U-V-W-X. NOTE: ERS IS DEDUCTED BECAUSE IT IS ONLY ATTRIBUTABLE TO COMMERCIAL USERS, AND IS ADDED BACK TO COMMERCIAL AIRFIELD O&M.

COLUMN Z:(HIDDEN) GROSS AIRFIELD COST (MFA AND EXMFA COSTS ARE INPUTTED FROM NET INCOME AIRSIDE STATEMENT IN THE ATAC APPENDIX AND EQUAL SALARIES+ BENEFITS+ OTHER DIRECT AND ARE IN 90/91 DOLLARS, FDA COSTS ARE ESTIMATED BY REGRESSING EXMFA AIRFIELD COSTS ON ATTRIBUTABLE COSTS RECOVERABLE FROM USERS).

COLUMN AA:(HIDDEN) AIRFIELD COSTS LESS ERS AND MILITARY & STATE = Z-V-X, EXCEPT WHERE THEY ARE ZERO WHERE ERS AND/OR S&M WAS TOO HIGH GIVING A NEGATIVE NUMBER, SO ZERO WAS ENTERED.

COLUMN AB: TOTAL AIRFIELD O&M COST = COLUMN AA (IF COLUMN W HAS A NUMBER IN IT OTHER THAN ZERO, THEN COLUMN Z WILL EQUAL  $AA \times (1 - \%)$  WHERE THE % IS THE ONE USED IN COLUMN W.

COLUMN AC:(HIDDEN) GROSS TERMINAL COST (MFA AND EXMFA COSTS ARE INPUTTED FROM NET INCOME GROUND SIDE STATEMENT OF ATAC APPENDIX AND IS EQUAL TO SALARIES+BENEFITS+OTHER DIRECT AND ARE IN 90/91 DOLLARS, AND THERE ARE NO FDA COSTS TO INPUT).

COLUMN AD: TOTAL TERMINAL O&M COST (FOR MFA AND EXMFA IS EQUAL TO AC-T, UNLESS A CERTAIN % IS USED FOR NON-ATTRIB COSTS WHERE IT THEN EQUALS  $(AC-T) \times (1 - \%)$  WHERE THE % IS DIFFERENT FOR FDAs AND MFA/EXMFAs, AND FDA COSTS EQUAL Y-AA UNLESS A CERTAIN % IS USED FOR NON-ATTRIB, THEN FDA COSTS EQUAL  $(W-Y) \times (1 - FDA\%)$ .

COLUMN AE:(HIDDEN) CAPITAL REPLACEMENT COST IN 90/91 DOLLARS (INPUTTED COSTS THAT WERE CALCULATED FROM TC SITE STATEMENTS AS DESCRIBED IN THE METHODOLOGY SECTION OF THE REPORT).

COLUMN AF:(HIDDEN) STRAIGHT LINE DEPRECIATION OVER 30 YEARS = COLUMN AE DIVIDED BY 30 YEARS, WHERE 30 YEARS IS THE AVERAGE LIFE OF ASSETS (20 YEARS BUILDINGS, 40 YEARS RUNWAYS).

COLUMN AG:(HIDDEN) COST OF CAPITAL = COLUMN AE\*INTEREST RATE(10%)\*FACTOR(50%).

COLUMN AH: TOTAL CAPITAL COST = COLUMN AF+AG.

COLUMN AI:(HIDDEN) BOOK VALUE OF EMERGENCY RESPONSE SERVICES' ASSETS (INPUTTED FROM SYPHER'S STUDY OF CFR, VOLUME II, APPENDIX ON ANNUAL CFR COSTS AND EQUALS VEHICLE COST+ FIREHALL COST AND IS 1986/87 DOLLARS).

COLUMN AJ: ERS PORTION OF CAPITAL =  $(AI \times \text{INFLATION FACTOR} / AE) \times AH$  = (BOOK VALUE INFLATED TO 90/91 DOLLARS DIVIDED BY CAPITAL REPAACEMENT COST(COLUMN AE) TIMES TOTAL CAPITAL COST(COLUMN AH).

COLUMN AK: TOTAL CAPITAL COST LESS ERS CAPITAL = COLUMN AH-AJ, ERS CAPITAL IS SUBTRACTED TO ALLOCATED CAPITAL BETWEEN GA AND COMMERCIAL, AND THEN ERS CAPITAL IS ADDED BACK TO COMMERCIAL AIRFIELD CAPITAL.

COLUMN AL: TOTAL TERMINAL CAPITAL COSTS =  $\% \times \text{AK}$  FOR MFAs WHERE THE % IS THE AMOUNT OF CAPITAL ATTRIBUTABLE TO TERMINAL TAKEN FROM 1990 TP1300 FROM BALANCE SHEET ASSETS (TERMINAL FIXED ASSETS/TOTAL FIXED ASSETS, BEFORE DEPRECIATION AND LAND) AND THEN MULTIPLIED BY TOTAL CAPITAL LESS ERS COSTS; AND FOR EXMFAs AND FDAs EQUALS  $(\text{AD}/(\text{AB} + \text{AD})) \times \text{AK}$ , WHERE TOTAL TERMINAL CAPITAL IS PRORATED BASED ON TERMINAL O&M COSTS OVER TOTAL O&M COST, THEN MULTIPLIED BY TOTAL CAPITAL LESS ERS (COLUMN AK).

COLUMN AM: TOTAL AIRFIELD CAPITAL COSTS =  $\% \times \text{AK}$  FOR MFAs WHERE THE % IS THE AMOUNT OF CAPITAL ATTRIBUTABLE TO AIRSIDE TAKEN FROM 1990 TP1300 FROM BALANCE SHEET ASSETS [(AIRFIELD FIXED ASSETS+ MACHINERY AND EQUIPMENT)/TOTAL ASSETS, BEFORE DEPRECIATION AND LAND] AND THEN MULTIPLIED BY TOTAL CAPITAL LESS ERS (COLUMN AK); AND FOR EXMFAs AND FDAs EQUALS  $(\text{AB}/(\text{AB} + \text{AD})) \times \text{AK}$ , WHERE AIRFIELD CAPITAL IS PRORATED BASED ON AIRFIELD O&M COSTS OVER TOTAL O&M COST, THEN MULTIPLIED BY TOTAL CAPITAL LESS ERS (COLUMN AK).

COLUMN AN: COMMERCIAL AIRFIELD O&M COST =  $\text{COLUMN AB} \times \text{COLUMN O} + (\text{COLUMN X INFLATED TO 90/91 DOLLARS})$ .

COLUMN AO: COMMERCIAL AIRFIELD OVERHEAD COSTS (NO OVERHEAD IS ALLOCATED TO MFAs) =  $72960 \times \text{COLUMN O} \times (\text{AB}/(\text{AB} + \text{AD})) \times ((\text{AN} + \text{AP} + \text{AY} + \text{BC})/(\text{TOTAL AN} + \text{TOTAL AP} + \text{TOTAL AY} + \text{TOTAL BC}))$  WHERE \$72960 IS TOTAL OVERHEAD IN 90/91 DOLLARS AND COMES FROM TP10041 T.C. PROPOSED NEW COST RECOVERY PAPER: PHASE II AND IS EQUAL TO AIRPORT DEPARTMENTAL OVERHEAD (44M) + ALLOCATION OF TC CORPORATE OVERHEAD (22M) LESS ERS OVERHEAD (2M) \* INFLATION FACTOR (1.14), COLUMN O = % THAT IS COMMERCIAL,  $(\text{AB}/(\text{AB} + \text{AD}))$  IS THE PORTION OF O/H THAT IS AIRFIELD, AND  $((\text{AN} + \text{AP} + \text{AY} + \text{BC})/(\text{TOTAL AN} + \text{TOTAL AP} + \text{TOTAL AY} + \text{TOTAL BC}))$  IS THE SITE ALLOCATION OF OVERHEAD COSTS.

COLUMN AP: COMMERCIAL TERMINAL O&M COST =  $\text{COLUMN AD}$  SINCE ALL TERMINAL COSTS ARE ALLOCATED TO COMMERCIAL, MFA AND EXMFA AND FDA ARE IN 90/91 DOLLARS.

COLUMN AQ: COMMERCIAL OVERHEAD COSTS (NO OVERHEAD IS ALLOCATED TO MFAs) =  $\text{TOTAL OVERHEAD COSTS IN 90/91 DOLLARS} \times \text{COLUMN O} \times (\text{AD}/(\text{AB} + \text{AD})) \times ((\text{AN} + \text{AP} + \text{AY} + \text{BC})/(\text{TOTAL AN} + \text{TOTAL AP} + \text{TOTAL AY} + \text{TOTAL BC}))$  WHERE TOTAL OVERHEAD = \$72960 IN 90/91 DOLLARS, COLUMN O = % THAT IS COMMERCIAL,  $(\text{AD}/(\text{AB} + \text{AD}))$  IS THE PORTION OF O/H THAT IS TERMINAL, AND  $((\text{AN} + \text{AP} + \text{AY} + \text{BC})/(\text{TOTAL AN} + \text{TOTAL AP} + \text{TOTAL AY} + \text{TOTAL BC}))$  IS THE SITE ALLOCATION OF OVERHEAD COSTS.

COLUMN AR: COMMERCIAL AIRFIELD CAPITAL COST =  $(\text{AM} \times \text{O}) + \text{AJ}$ , WHERE AM IS TOTAL AIRFIELD CAPITAL COSTS MULTIPLIED BY THE % THAT IS COMMERCIAL (COLUMN O) AND THEN ADD BACK ERS CAPITAL (COLUMN AJ).

COLUMN AS: COMMERCIAL TERMINAL CAPITAL COST = COLUMN AL WHERE AL IS TOTAL TERMINAL COSTS WHICH ARE ENTIRELY ATTRIBUTABLE TO COMMERCIAL.

COLUMN AT: TOTAL COMMERCIAL AIRFIELD COSTS =  $AN + AO + AR$ .

COLUMN AU: TOTAL COMMERCIAL TERMINAL COSTS =  $AP + AQ + AS$ .

COLUMN AV: TOTAL COMMERCIAL COSTS IN 90/91 DOLLARS =  $AT + AU$ .

COLUMN AW:(HIDDEN) REVENUE FROM AIRLINES (FOR MFA AND EXMFA REVENUES ARE INPUTTED AND EQUAL TO TOTAL REVENUE FROM NET INCOME AIRSIDE STATEMENT IN ATAC APPENDIX PLUS GTF+RENTALS+OTHER FROM NET INCOME GROUND SIDE STATEMENT IN ATAC APPENDIX, AND FDA REVENUES EQUAL AIRSIDE FEES AND CONCESSIONS + PASSENGER AND CARGO FACILITIES FROM TC STATEMENT OF REVENUES AND EXPENSES, MFA REVENUES ARE IN 90/91 DOLLARS AND EXMFA AND FDA REVENUES ARE IN 87/88 DOLLARS.

COLUMN AX: COMMERCIAL REVENUE FROM AIRLINES 90/91 =  $COLUMN\ AR * 1.14$  EXCEPT FOR THE MFAs.

COLUMN AY: GA IFR AIRFIELD O&M COST =  $(AB * (1-O)) * (1-P)$ , WHERE COLUMN AB = TOTAL AIRFIELD O&M, 1-O = PORTION ATTRIBUTABLE TO GA, AND 1-P = PORTION ATTRIBUTABLE TO IFR GA, AND IS IN 90/91 DOLLARS (EXMFA AND FDA MULTIPLIED BY 1.14).

COLUMN AZ: GA IFR AIRFIELD OVERHEAD COSTS (ZERO FOR MFAs) =  $(1-O) * (1-P) * 72960 * ((AN + AP + AY + BC) / (AN\ TOTAL + AP\ TOTAL + AY\ TOTAL + BC\ TOTAL))$ , WHERE 1-O = GA PORTION, 1-P = IFR PORTION, 72960 = TOTAL OVERHEAD COSTS IN 90/91 DOLLARS, AND  $((AN + AP + AY + BC) / (AN\ TOTAL + AP\ TOTAL + AY\ TOTAL + BC\ TOTAL))$  IS THE ALLOCATION OF OVERHEAD COSTS TO THAT PARTICULAR SITE.

COLUMN BA: GA IFR CAPITAL COSTS =  $AM * (1-O) * (1-P)$ , WHERE AM IS TOTAL AIRFIELD CAPITAL COST AND (1-O) IS THE % THAT IS GA'S CAPITAL COST, AND 1-P IS GA IFR'S PORTION.

COLUMN BB: TOTAL GA IFR COSTS =  $AY + AZ + BA$ .

COLUMN BC: GA VFR AIRFIELD O&M COST =  $AB * (1-O) * P$ , WHERE AB IS TOTAL O&M COSTS, 1-O IS GA'S PORTION, AND P IS GA VFR'S PORTION, AND ALL ARE EXPRESSED IN 90/91 DOLLARS (EXMFA AND FDA MULTIPLIED BY 1.14).

COLUMN BD: GA VFR AIRFIELD OVERHEAD COSTS (ZERO FOR MFAs) =  $(1-O) * P * 72960 * ((AN + AP + AY + BC) / (AN\ TOTAL + AP\ TOTAL + AY\ TOTAL + BC\ TOTAL))$ , WHERE 1-O = GA PORTION, P = VFR PORTION, \$72960 = TOTAL OVERHEAD COSTS IN 90/91 DOLLARS, AND  $((AN + AP + AY + BC) / (AN\ TOTAL + AP\ TOTAL + AY\ TOTAL + BC\ TOTAL))$  IS THE ALLOCATION OF OVERHEAD COSTS TO THAT PARTICULAR SITE.

COLUMN BE: GA VFR CAPITAL COSTS =  $AM \cdot (1-O) \cdot P$ , WHERE AM IS TOTAL AIRFIELD CAPITAL COST AND (1-O) IS THE % THAT IS GA'S CAPITAL COST, AND P IS GA VFR'S PORTION.

COLUMN BF: TOTAL GA VFR COSTS =  $BC + BD + BE$ .

COLUMN BG: TOTAL GA COSTS 90/91 =  $BB + BF$ .





O&M ENROUTE COSTS	\$253,845,000
COMMERCIAL/IFR ENROUTE COSTS	\$51,074,000
VFR ENROUTE COSTS	
OVERHEAD COSTS	
COMMERCIAL/IFR ENROUTE COSTS	\$76,846,000
VFR ENROUTE COSTS	\$15,462,000
CAPITAL ENROUTE COSTS	
COMMERCIAL/IFR ENROUTE CAPITAL COSTS	\$27,000,000
VFR ENROUTE COSTS	\$7,900,000
COMMERCIAL/IFR ENROUTE COST CAPITAL	\$1,350,000
VFR ENROUTE COST COST OF CAPITAL	\$395,000
TOTAL DOMESTIC ENROUTE ANS COST	
COMMERCIAL/IFR ENROUTE COSTS	\$359,041,000
VFR ENROUTE COSTS	\$74,831,000

TOTAL GA HOURS FLOWN IN 1988	921000
% OF DOMESTIC GA	86.74%
% OF DOMESTIC IFR GA	58.12%
TOTAL DOMESTIC IFR GA HOURS FLOWN	464,272
TOTAL DOMESTIC VFR GA HOURS FLOWN	334,589
AVERAGE KMS/HOUR USING CESSNA 172	222
IFR GA KMS FLOWN DOMESTICALLY	103,246,674
VFR GA KMS FLOWN DOMESTICALLY	74,407,232

E/D DOMESTIC PAX	24,524,000
COMMERCIAL DOMESTIC PAX-KMS LEVELS 1-4	24,615,710,000
TOTAL COMMERCIAL DOMESTIC MOVEMENTS	2,348,994
COMMERCIAL KMS FLOWN DOMESTICALLY	2,357,778,303
% ENROUTE COSTS ATTRIB TO COMMERCIAL	95.80%
ENROUTE COSTS ATTRIB TO COMMERCIAL	\$343,978,256
COST PER COMMERCIAL DOMESTIC KMS	\$0.15
ENROUTE COSTS ATTRIB TO IFR GA	\$15,062,744
COST PER IFR GA DOMESTIC KMS	\$0.15
ENROUTE COSTS ATTRIB TO VFR GA	\$74,831,000
COST PER VFR GA DOMESTIC KMS	\$1.01

O&M LOCAL ANS COST	
COMMERCIAL/IFR LOCAL COST	\$127,333,000
FSS LOCAL COST	\$46,723,000
OVERHEAD COSTS	
COMMERCIAL/IFR LOCAL COST	\$38,548,000
FSS LOCAL COST	\$14,144,000
LOCAL ANS CAPITAL COST	
COMMERCIAL/IFR LOCAL CAPITAL COST	\$38,500,000
FSS LOCAL CAPITAL COST	\$3,500,000
COMMERCIAL/IFR LOCAL COST OF CAPITAL	\$1,925,000
FSS LOCAL COST OF CAPITAL	\$175,000
TOTAL LOCAL ANS COST	
COMMERCIAL/IFR LOCAL COST	\$206,306,000
FSS LOCAL COST	\$64,542,000

TOTAL COMMERCIAL ITINERANT TOWER MOVEMENTS	2,647,328
TOTAL COMMERCIAL ITINERANT FSS MOVEMENTS	579,466
TOTAL GA ITINERANT TOWER MOVEMENTS	652,359
TOTAL GA ITINERANT FSS MOVEMENTS	175,833
TOTAL GA IFR TOWER MOVEMENTS	339,227
TOTAL GA IFR FSS MOVEMENTS	49,233
TOTAL GA VFR TOWER MOVEMENTS	2,463,747
TOTAL GA VFR FSS MOVEMENTS	380,672
% LOCAL COSTS ATTRIB TO COMMERCIAL	48.57%
% LOCAL FSS COSTS ATTRIB TO COMMERCIAL	57.41%
% LOCAL COSTS ATTRIB TO IFR GA	6.22%
% LOCAL FSS COSTS ATTRIB TO IFR GA	4.88%
% LOCAL COSTS ATTRIB TO VFR GA	45.20%
% LOCAL FSS COSTS ATTRIB TO VFR GA	37.71%
LOCAL COSTS ATTRIB TO COMMERCIAL	\$137,259,901
LOCAL ANS COST PER ARRIVAL FOR COMMERCIAL	\$42.54
LOCAL COSTS ATTRIB TO IFR GA	\$15,988,592
LOCAL ANS COST PER ARRIVAL FOR IFR GA	\$41.16
LOCAL COSTS ATTRIB TO VFR GA	\$117,599,507
LOCAL ANS COST PER ARRIVAL FOR VFR GA	\$41.34

COMMERCIAL ANS COST FUNCTION \$42.54/ARRIVAL +\$0.15/Km

GA IFR ANS COST FUNCTION \$41.16/ARRIVAL +\$0.15/Km

GA VFR ANS COST FUNCTION \$41.34/ARRIVAL +\$1.01/Km



## **APPENDIX E**

### **INFRASTRUCTURE COST MODEL DATA (WEIGHT BASED)**











## **APPENDIX F**

### **U.S. COST MODEL FOR ALLOCATION OF FAA INFRASTRUCTURE COSTS**



## **A. U.S. COST ALLOCATION PRACTICES**

One of the first tasks completed was a review of the model used to allocate Federal Aviation Administration (FAA) infrastructure costs to various aviation user groups. The review was undertaken to gain a further understanding of the practices and methodology for cost allocation used in other aviation jurisdictions.

The FAA study was completed in 1986, and is updated every five years. It uses a number of theoretical economic models to apportion costs among the various groups who are benefactors of the wide range of services and facilities provided by the FAA. A summary of the study is provided below.

### **1. Costs**

The U.S. has broken down federal airport and airway costs into six general cost centers.

- **Operating Site Costs:** labour, maintenance and leased communications costs at Air Route Traffic Control Centers (ARTCC's), Flight Service Stations (FSS's), towers and Towers equipped with Radar Approach Control Services (TRACON's). This is equivalent to the Canadian ANS operating costs.
- **Facilities and Equipment Costs:** capital expenditures made by the FAA to replace or improve facilities or equipment. This is equivalent to the Canadian ANS Capital costs.
- **Research and Development:** expenditures made by the FAA on R&D programs consistent with its mandate to build and maintain an efficient and safe airport and airways system. There is no direct equivalent in Canada, although some TDC projects are in aviation.
- **Airport Grants:** grants made to operators of primary, commercial, reliever and general aviation airports. There is no direct equivalent in Canada. It would equate to a significant portion of airport airfield capital costs.

- **NAVAID Maintenance and Regulatory Costs:** costs incurred by the FAA in maintaining navigation and other equipment not located at operating sites and of regulating aircraft operations and manufacturing, and airports. This does not match Canadian programs, but would be somewhat comparable to Regulatory and Safety Programs.
- **Overhead:** Costs of headquarters and regional administration, and procurement.

## **2. User Groups**

These costs are allocated among 10 users that are grouped into three general categories. The three categories are:

- **Airlines** - domestic air carriers, international air carriers, freight air carriers, and commuter air carriers.
- **General Aviation** - air taxis, operators of general aviation piston aircraft, turboprop and turbojet aircraft, and operators of rotorcraft. The inclusion of air taxis means that the definition is different than in Canada, where this group would be included in charter or other commercial.
- **Public Sector** - military and civil government users, and public interest expenditures.

Under full cost allocation, the entire FAA budget is assigned to 10 user groups and to the public interest. A six step procedure is employed.

**Step 1** - The FAA budget is separate into identifiable cost centers.

**Step 2** - Cost center resources expended in the public interest are identified and defined as resources expended to produce public goods, redress externalities, or benefit non-aviators.

**Step 3** - The use of each cost center by each user group is estimated.

**Step 4** - For each user group, the cost that would be avoided if it no longer utilized services produced by the cost center is estimated.

**Step 5** - For each cost center, the joint costs are identified as those costs not avoidable by any single user group, but avoidable by all users together.

**Step 6 - Joint costs are distributed among users.**

The result of this six step procedure is that each user group is assigned two components of costs for each cost center - avoidable costs and a share of joint costs.

### **3. Methodology To Allocate Costs Amongst User Groups**

The cost of R&D and Airport Grants do not pertain to Canadian Cost Allocation and will not be examined. It should also be noted that costs were allocated based on the FAA establishing user charges to recover these costs, hence cost is treated equal to price.

#### **Assignment of Operating Site Costs to Users**

In the case of FAA operating sites (ARTCC's, FSS's, towers, TRACON's) econometric cost functions were estimated in order to identify the marginal cost of the use of these services by the following aggregate user groups:

- Airlines (Domestic, International, and Freight Carriers);
- Commuter Airlines;
- General aviation and other users including civil government and air taxi operators; and
- Military.

By combining cost and user group activity statistics, the following cost function is derived:

$$\text{Cost} = \text{Constant} + MC_i (\text{Activity Measure}_i)$$

This cost function provides estimates of both marginal costs by user group and joint site costs. This equation says that the cost of operating an operating site such as an ARTCC depends on the amount of activity at the site, and on other resource costs which do not vary with activity, as explained by the constant. The term  $MC_i$  is the estimated long-run marginal (additional) cost to the FAA of one more unit of service provided to user group  $i$ . By multiplying the marginal cost of a particular user group by their activity measure, it is possible to estimate total variable costs attributable to each user group. The variable costs are then assigned to the 10 categories of users.

Joint costs are allocated among the ten user groups based on activity, estimated marginal costs and relative demand elasticities. In principle, Ramsey Pricing minimizes the loss in net benefits due to setting the price above marginal cost. This is accomplished by varying the percentage markup above marginal costs inversely with demand elasticities. By charging higher prices to inelastic users, the change in net benefits is minimized, since inelastic users are less sensitive to price changes.

The elasticity of demand for ga piston users is higher than that of other users. The reason being that the three components of demand elasticity are higher for ga users, ie. substitution elasticity, income elasticity, and the ratio of purchases of a product to income.

#### **Assigning Facility and Equipment Costs**

Avoidable costs are used to identify attributable user costs pertaining to facilities and equipment (F&E). Avoidable costs are defined as those costs which would disappear if a user group no longer consumed a service. Included in avoidable costs are both short-term variable costs and other non-variable costs attributable to a particular user's consumption of FAA services. Avoidable costs are the closest practical measure of long-run marginal cost that is available.

Each line item in the budget for F&E is evaluated to determine if some or all of it would be avoided if the following general user group categories no longer consumed the services produced in that cost category:

- Air Carriers;
- General Aviation;
- IFR Aviators (whether air carriers, ga, or government);
- flying under Instrument Flight Rules (IFR); and
- Public Interest.

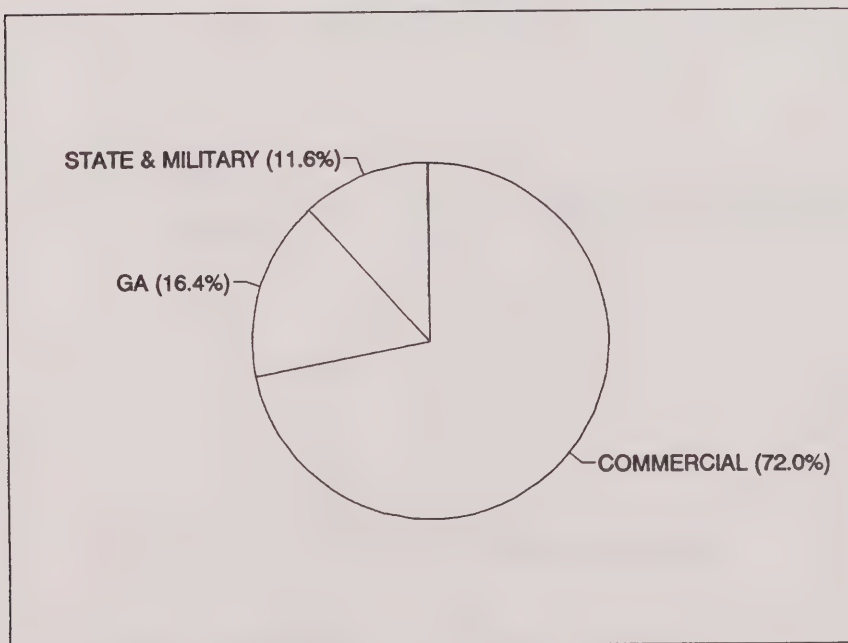
When a line item could not be assigned to one of these categories, it was assigned to all users as a group. Then these costs were allocated among the ten user groups. Public sector costs were attributed directly to military or government users, or to the public in general. The remaining costs were assigned to users based on Ramsey Pricing as a markup above marginal costs. Ramsey Pricing was used when marginal costs were not well defined for some services, and when the revenue collected by marginal cost based taxes was insufficient to cover the total costs of FAA

operations. For example, an F&E project undertaken specifically at ARTCCs for IFR users would be allocated among IFR users as a markup above ARTCC marginal costs. When the line item was not related directly to a particular type of operating site, the allocation was based upon each user group's total use of the FAA airway system.

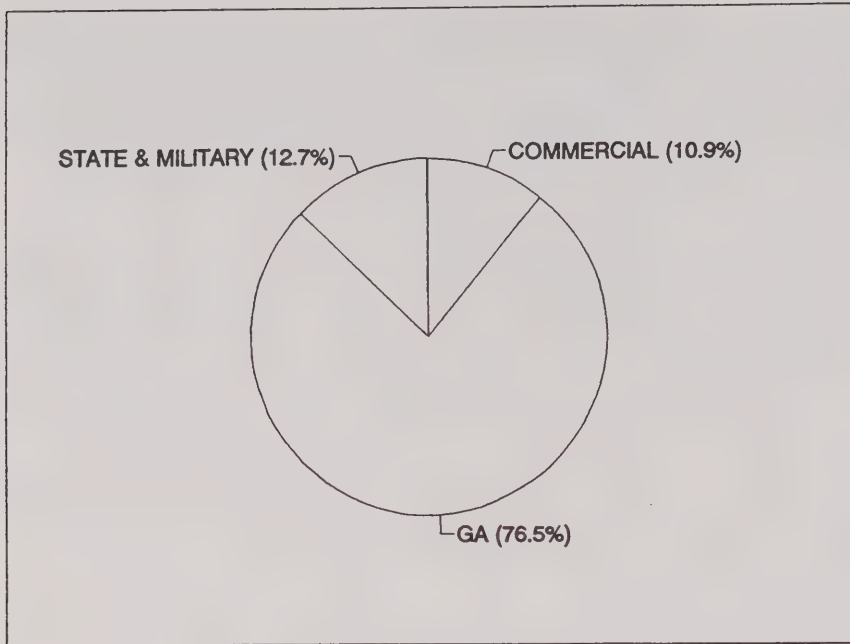
#### **Assigning Overhead and Indirect Costs**

These costs were attributed by identifying the various departments within FAA supported by these overhead activities. The overhead items were distributed among these departments based on the number of employees supported, or other statistics that reliably relate the overhead activity to a department it supports. Ultimately, the overhead items were distributed to final outputs of the FAA such as air traffic services or facilities and equipment. Once assigned to these major cost categories, the overhead items were distributed to the ten user groups by applying Ramsey Pricing or the Avoidable Cost method.

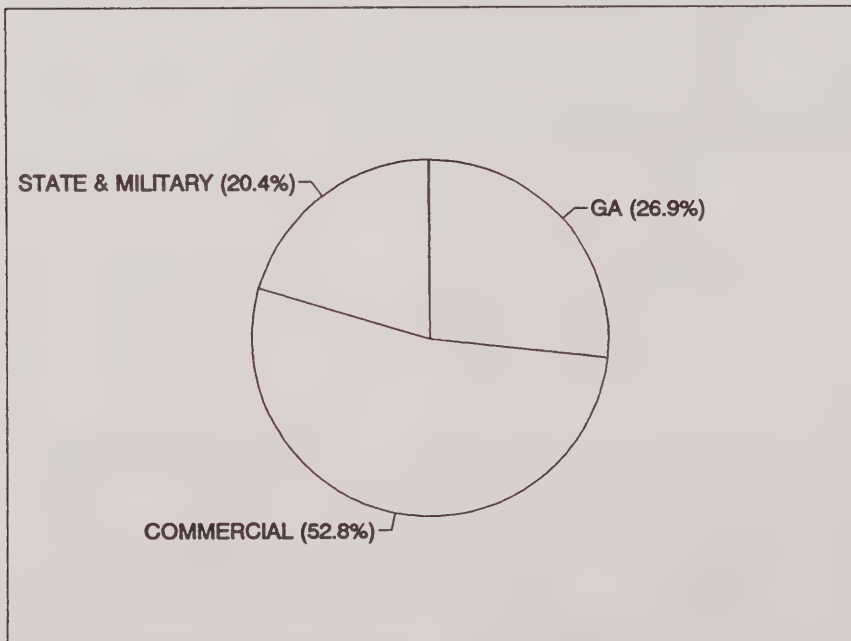
Exhibits F-1 to F-5 summarize the allocation of relevant U.S. airport costs.



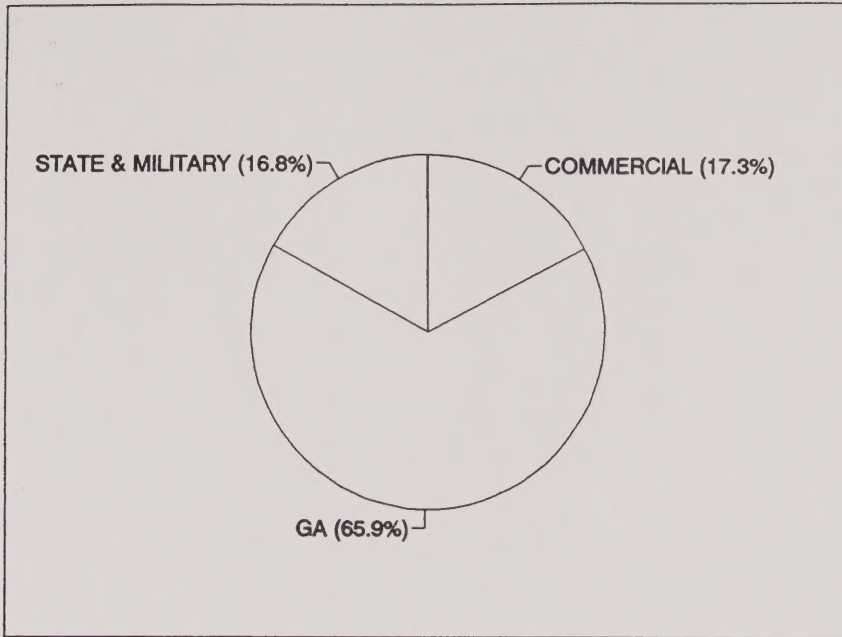
**Exhibit F-1. Allocation of Facility and Equipment Costs**



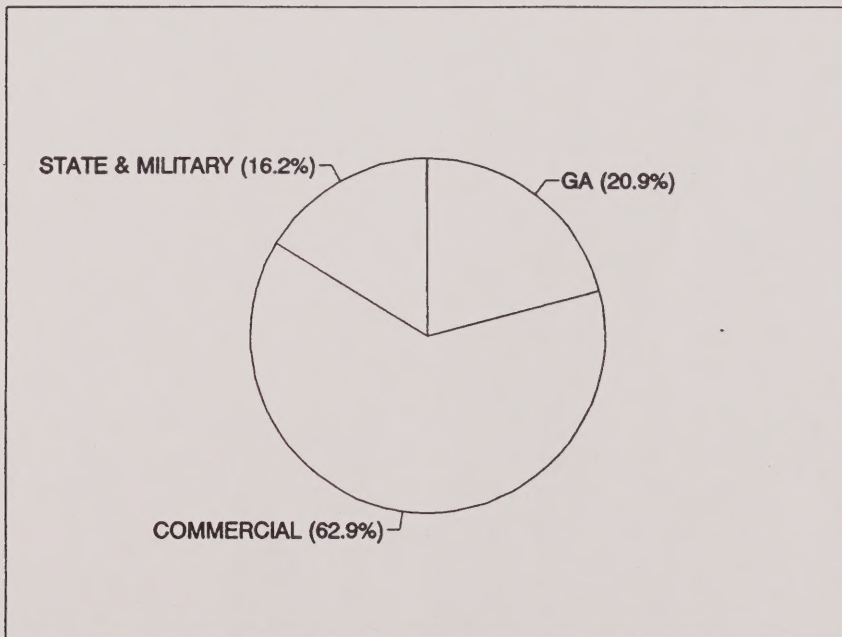
**Exhibit F-2. Allocation of FSS O&M Costs**



**Exhibit F-3. Allocation of Navaid Maintenance Costs**



**Exhibit F-4. Allocation of Tower O&M Costs**



**Exhibit F-5. Allocation of TRACON O&M Costs**





